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N° XI.

Deſcription of a Machine for Meaſuring a Ship's Way through the Sea, by F. HOPKINSON, *Eſquire.*

Read July 11, 1783. THE errors and uncertainties incident to the mariner's log, in common uſe, are too obvious not to be univerſally acknowledged. Were it not for the obſervations navigators are accuſtomed to make of a ſhip's progreſs, by the apparent paſſage of the water along ſide, and the ſigns that uſually preſent on approaching the land, the log, alone, would be a very unſafe dependence.

Several attempts have, therefore, been made to improve the log, and render its indications more accurate, but without ſucceſs. All the machines of this kind, that I have heard of, were compoſed of a number of wheels, which were to be put in motion by the twiſting of a line let out aſtern, having a drag at the end ſo conſtructed as to whirl round, faſter or ſlower, according to the motion of the ſhip.

The objections to a machine, ſo conſtructed, are, *Firſt*, If the line is not very long the drag will be conſiderably affected by the ſhip's wake; and, if it is very long, the twiſtings will be irregular, and the line liable to kink. *Secondly*, If the drag is ſo heavy as to ſink below the bottoms of the waves, when the ſhip ſails faſt, it will be too heavy, and ſink too deep when ſhe hath but a ſlow progreſſive motion: Or, otherwiſe, if the drag is of a proper weight when ſhe makes but little way, it will ſkip from wave to wave through the air when ſhe ſails with a briſk gale, and ſo be of no uſe. And, *Thirdly*, It will be liable to moſt of the other irregularities to which the log in common uſe is expoſed.

The machine now propoſed will, it is hoped, be free from, at leaſt, ſome of theſe objections. And, although it may not be able to aſcertain a ſhip's way through the ſea to a mathematical preciſion, yet if it ſhould be found to anſwer the purpoſe better than any inſtrument hitherto contrived, it may be admitted as an acquiſition to the art of navigation.

This machine, in its moſt ſimple form, is repreſented by *Fig.* 1, *Plate* 3. Wherein AB is a ſtrong rod of iron moveable on the fulcrum C. D is a thin circular plate of braſs rivetted to the lower extremity of the rod. E an horizontal arm connected at one end with the top of the rod AB by a moveable joint F, and at the other end with the bottom of the index H by a like moveable joint G. H is the index turning on its centre I and travelling over the graduated arch K; and L is a ſtrong ſpring bearing againſt the rod AB and conſtantly counteracting the preſſure upon the palate D. The rod AB ſhould be applied cloſe to one ſide of the cut water or ſtem, and ſhould be of ſuch a length that the palate D may be no higher above the keel than is neceſſary to ſecure it from injury when the veſſel is aground or ſails in ſhoal water. As the bow of the ſhip curves inward towards the keel M, the palate D will be thrown to a diſtance from the bottom of the veſſel, although the perpendicular rod, to which it is annexed, lies cloſe to the bow above; and, therefore, the palate will be more fairly acted upon. The arm E ſhould enter the bow ſomewhere near the hawſer hole, and lead to any convenient place in the forecaſtle, where a ſmooth board or plate may be fixed, having the index H and graduated arch K upon it.

It is evident from the figure, that as the ſhip is urged forward by the wind, the palate D will be preſſed upon by the reſiſting medium, with a greater or leſs force according to the progreſſive motion of the ſhip: and this will operate upon the levers ſo as to immediately affect the index; making the leaſt encreaſe or diminution of the ſhip's way

way viſible on the graduated arch. The ſpring L always counteracting the preſſure upon the palate, and bringing back the index on any relaxation of the force impreſſed.

A ſhip going through the ſea opens a paſſage for herſelf, making a hole in the water equal to her immerged bulk. As ſhe paſſes on, this vacancy is filled up by the tumbling in of the waters from each ſide, and from underneath, at the ſtern, with great violence. So that there is a fair current of water from her bow to her ſtern, paſſing under the bottom and along ſide; the force of which current is in direct proportion to the velocity of the ſhip's progreſſive motion. This machine is, therefore, advantageouſly placed at the bow of the ſhip, where the current firſt begins, and acts fairly upon the palate; in preference to the ſtern, where the tumultuous cloſing of the waters cauſes a wake, viſible to a great diſtance. The palate D is ſunk nearly as low as the keel, that it may not be influenced by the heaping up of the water, and the daſhing of the waves at and near the water-line. The arch K is to aſcertain how many knots or miles ſhe would run in one hour, at her then rate of ſailing. But the graduations on this arch muſt be unequal; becauſe the reſiſtance of the ſpring L will encreaſe as it becomes more bent; ſo that the index will travel over a greater ſpace from one to five miles (which I ſuppoſe to be a medium) than from five to twelve. Laſtly, the palate, rod, ſpring and all the metallic parts of the inſtrument ſhould be covered with a ſtrong varniſh, to prevent ruſt from the corroſive quality of the ſalt water and ſea air.

IMPROVEMENT OF THIS MACHINE.

Let the rod or ſpear AB *Fig.* 1, be a round rod of iron or ſteel; and inſtead of moving on the fulcrum or joint as at C, let it paſs through and turn freely in a ſocket, to which ſocket the moveable joint muſt be annexed as, repreſented

preſented in *Fig.* 2. The rod muſt have a ſhoulder to bear on the upper edge of the ſocket, to prevent its ſlipping quite down. The rod muſt alſo paſs through a like ſocket at F, *Fig.* 1. The joint of the lower ſocket muſt be fixed to the bow of the ſhip, and the upper joint or ſocket muſt be connected with the horizontal arm E. On the top of the uppermoſt ſocket, let there be a ſmall circular plate, bearing the 32 points of the mariner's compaſs; and let the top of the rod AB come through the centre of this plate, ſo as to carry a ſmall index upon it, as is repreſented in *Fig.* 3. This ſmall index muſt be fixed to the top of the rod on a ſquare; ſo, that by turning the index round the plate, the rod may alſo turn in the ſockets, and of courſe carry the palate D round with it. The little index always pointing in a direction with the face of the palate. The ſmall compaſs plate ſhould not be faſtened to the top of the ſocket, but only fitted tightly on, that it may be moveable at pleaſure. Suppoſe, then, the intended port to bear ſouth-weſt from the place of departure; the palate muſt be turned on the ſocket till the ſouth-weſt point thereon looks directly to the ſhip's bow; ſo that the ſouth-weſt and north-eaſt line on the compaſs plate may be preciſely parallel with the ſhip's keel; and in this poſition the plate muſt remain during the whole voyage. Suppoſe then the ſhip to be ſailing in the direct courſe of her intended voyage, with her bowſprit pointing ſouth-weſt, let the little index be brought to the ſouth-weſt point on the compaſs plate, and the palate D will neceſſarily preſent its broad face toward the port of deſtination; and this it muſt always be made to do, be the ſhip's ſailing courſe what it may. If, on account of unfavourable winds, the ſhip is obliged to deviate from her intended courſe, the little index muſt be moved ſo many points from the ſouth-weſt line of the compaſs plate, as the compaſs in the binnacle ſhall ſhew that ſhe deviates from her true courſe. So that, in whatever direction the ſhip ſhall ſail, the palate D will always

always look full to the ſouth-weſt point of the horizon, or towards the port of deſtination; and, conſequently, will preſent only an oblique ſurface to the reſiſting medium—more or leſs oblique as the ſhip deviates more or leſs from the true courſe of her voyage. As, therefore, the reſiſtance of the water will operate leſs upon the palate in an oblique than in a direct poſition, in exact proportion to its obliquity, the Index H will not ſhew how many knots the veſſel runs in her then courſe, but will (it is expected) indicate how many ſhe gains in the direct line of her intended voyage. Thus, in *Fig.* 5, if the ſhip's courſe lies in the direction of the line AB, but ſhe can ſail by the wind no nearer than AC; ſuppoſe then, her progreſſive motion ſuch as to perform AC, equal to five knots or miles in one hour; yet the index H will only point to four knots on the graduated arch, becauſe ſhe gains no more than at that rate on the true line of her voyage, viz. from A to B. Thus will the difference between her real motion and that pointed out by the index be always in proportion to her deviation from the intended port, until ſhe ſails in a line at right angles therewith, as AD; in which caſe the palate would preſent only a thin ſharp edge to the reſiſting medium; the preſſure of which ſhould not be ſufficient to overcome the friction of the machine, and the bearing of the ſpring L. So that at whatever rate the ſhip may ſail on that line yet the index will not be affected: Shewing that ſhe gains nothing on her true courſe. In this caſe, and alſo when the veſſel is not under way, the action of the ſpring L ſhould cauſe the index to point at 0; as repreſented by the dotted lines in figure 1 and 4.

As the truth of this inſtrument muſt depend on the equal preſſure of the reſiſting medium upon the palate D according to the ſhip's velocity, and the proportionable action of the ſpring L, there ſhould be a pin or ſcrew at the joints C and F, ſo that the rod may be readily unſhipped and taken in, in order to clean the palate from any foulneſs

foulneſs it may contract; which would greatly increaſe its operation on the index H, and thereby render the graduated arch, falſe and uncertain.

Further, the ſpring L may be expoſed too much to injury from the ſalt water, if fixed on the outſide of the ſhip's bow. To remedy this it may be brought under cover by conſtructing the machine as repreſented by figure 4. Where, A B is the rod, C the fulcrum or centre of its motion; D the palate; E the horizontal arm leading through a ſmall hole into the forecaſtle: M is a ſtrong chain, faſtened at one end to the arm E and at the other to a rim or barrel on the wheel G, which by means of its teeth gives motion to the ſemicircle I and index H. The ſpring L is ſpiral and encloſed in a box or barrel, like the main ſpring of a watch: A ſmall chain is fixed to and paſſing round the barrel is faſtened by the other end to the fuzee W. This fuzee is connected by its teeth with the wheel G, and counteracts the motion of the palate D. NN are the two ſockets through which the rod A B paſſes, and in which it is turned round by means of the little index R. S is the ſmall compaſs plate, moveable on the top of the upper ſocket N. The plate S hath an upright rim round its edge cut into teeth or notches; ſo that when the index R is a little raiſed up, in order to bring it round to any intended point, it may fall into one of theſe notches and be detained there: Otherwiſe the preſſure of the water will force the palate D from its oblique poſition, and turn the rod and index round to the direction in which the ſhip ſhall be then ſailing. Should it be apprehended that the palate D, being placed ſo far forward, may affect the ſhip's ſteerage or obſtruct her ſailing, it ſhould be conſidered that a very ſmall plate will be ſufficient to work the machine. I ſhould ſuppoſe that one of three or four inches in diameter would fully anſwer the purpoſe: And yet not be large enough to have any ſenſible operation on the helm or ſhip's way.

The

The greateſt difficulty, perhaps, will be in graduating the arch K; (if the machine is conſtructed as in *figure* 1,) the unequal diviſions of which can only be aſcertained by actual experiment on board of each ſhip reſpectively; in as much as the accuracy of theſe graduations will depend on three circumſtances, viz. The poſition of the fulcrum C with reſpect to the length of the rod, the ſize of the palate D and the ſtrength or bearing of the ſpring L. When theſe graduations, however, are once aſcertained for the machine on board of any one veſſel, they will not want any future alterations; provided the palate D be kept clean, and the ſpring L retains its elaſticity.

But the unequal diviſions of the graduated arch will be unneceſſary, if the machine is conſtructed as in *figure* 4. For as the chain goes round the barrel L, and then winds through the ſpiral channel of the fuzee W, the force of the main-ſpring muſt operate equally, or nearly ſo, in all poſitions of the index; and conſequently, the diviſions of the arch K may, in ſuch caſe, be equal.

After all, it is not expected that a ſhip's longitude can be determined to a mathematical certainty by this inſtrument. The irregular motions and impulſes to which a ſhip is continually expoſed, make ſuch an accuracy unattainable perhaps by any machinery: But if it ſhould be found, as I flatter myſelf it will on fair experiment, that it anſwers the purpoſe much better than the common log, it may be conſidered as an acquiſition to the art of navigation.

It ſhould be obſerved that in aſcertaining a ſhip's longitude by a time-piece, this great inconvenience occurs, that a ſmall and trifling miſtake in the time, makes a very great and dangerous error in the diſtance run: Whereas the errors of this machine will operate no farther than their real amount; which can never be great or dangerous, if corrected by the uſual obſervations made by mariners for correcting the common log.

A like machine made in its ſimple form, (as at fig. 1.) ſo conſtructed as to ſhip and unſhip, might occaſionally

be applied along ſide about midſhips in order to aſcertain the lee-way; which, if rightly ſhewn will give the ſhip's preciſe longitude. As to ſea-currents, this and all other machines hitherto invented, muſt be ſubject to their influence; and proper allowances muſt be made, according to the ſkill and knowledge of the navigator.

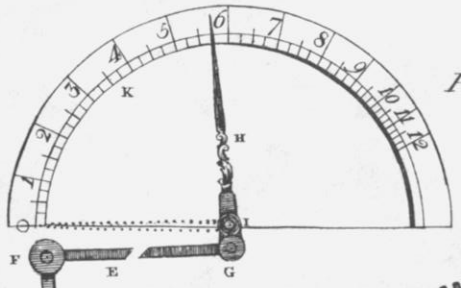
Laſtly, ſome diſcretion will be neceſſary in taking obſervations from the machine to be entered on the log-book. I mean, that the moſt favourable and equitable moment ſhould be choſen for the obſervation. Not whilſt the ſhip is rapidly deſcending the declivity of a wave; or is ſuddenly checked by a ſtroke of the ſea; or is in the very act of plunging. In all caſes, I ſuppoſe, periods may be found in which a ſhip proceeds with a true average velocity; to diſcover which a little experience and attention will lead the ſkilful mariner*

N° XII.

Account of an Electrical Eel, or the Torpedo of Surinam, by WILLIAM BRYANT, *Eſquire.*

SURINAM a colony of South America belonging to the ſtates of Holland, abounds with as many natural curioſities as any country in the world. But that which I look upon to be as ſurpriſing as any in it, and which I believe has not yet been accurately deſcribed, is a fiſh of the ſpecies of eel, and is caught there in nets among other fiſh; generally in muddy rivers, and I believe is found in moſt of the neighbouring provinces. In ſize and colour

* An ingenious mechanic would probably conſtruct this machine to better advantage in many reſpects. The author only meant to ſuggeſt the principle; experiment alone can point out the beſt method of applying it. He is ſenſible of at leaſt one deficiency, viz. That the little index R, figure 4, will not be ſtrong enough to retain the palate D in an oblique poſition when the ſhip is ſailing by the wind; more eſpecially as the compaſs plate S, in whoſe notched rim the index R is to fall, is not fixed to, but only fitted tight on the ſocket N. Many means however might be contrived to remedy this inconvenience.



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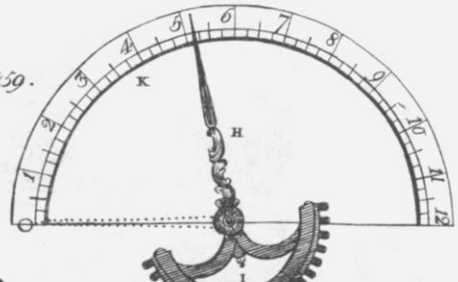

Fig. 1.

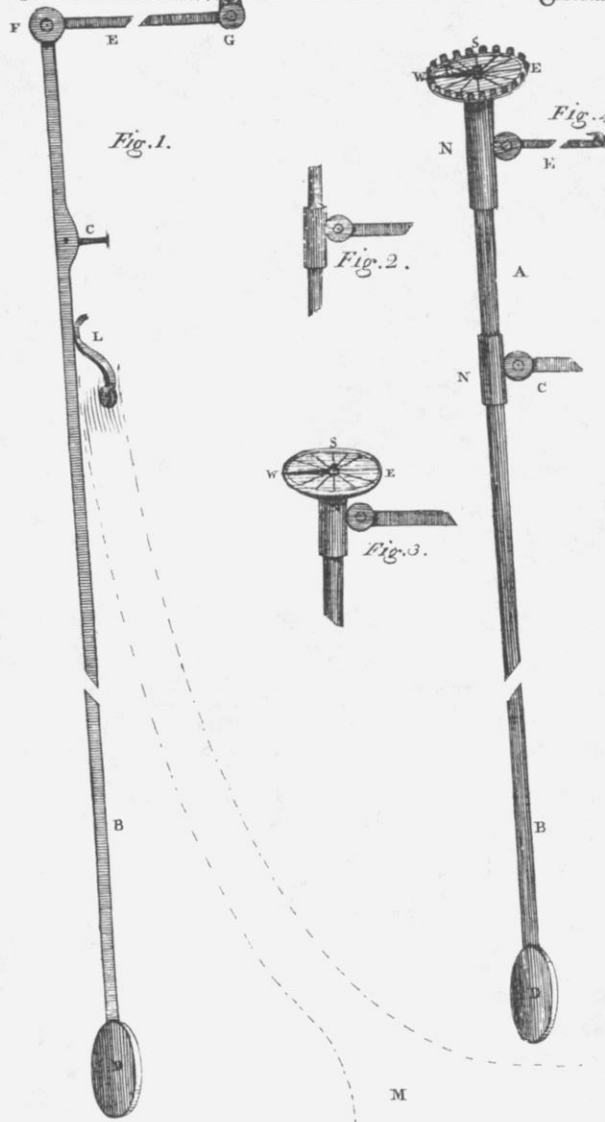

Fig. 2.

Fig. 3.

Fig. 4.

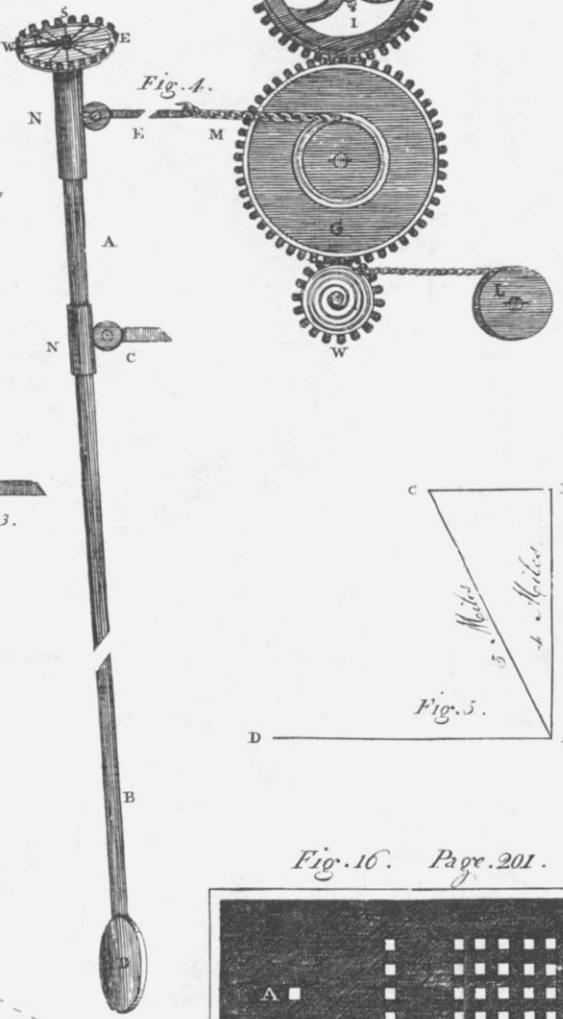

Fig. 5.

Fig. 16. Page. 201.

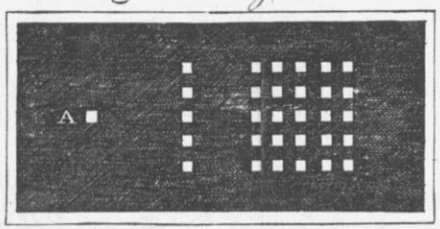

Fig. 6.

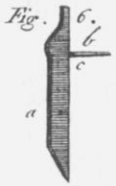

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

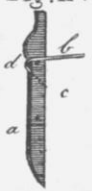

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Fig. 12.

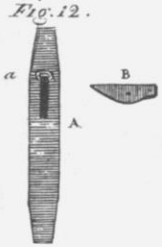


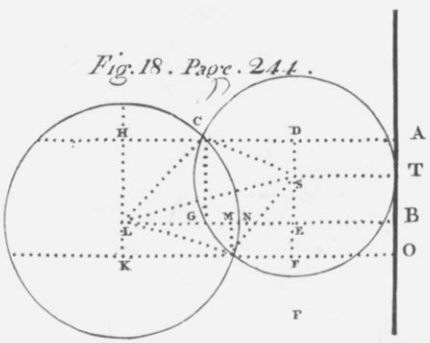
Fig. 13.

Fig. 14.

Fig. 15.

Fig. 17.

Fig. 18. Page. 244.



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